Empowering Runners: Creating a Generator to Harness the Motion of the Human Body

(Technical Paper)

Using Collaborative Stormwater Solutions of the Past to Inform the Future

(STS Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Introduction

Albemarle County is facing a water crisis, due not to a lack of the resource but a messy and poorly managed overabundance. Stormwater and runoff control is lacking and has perpetual impacts on the infrastructure, environment, and residents of the area. Creating a better system has not been possible due to a lack of cooperation between individual landowners and the local government/community. To make progress, these landowners must be persuaded to work with the community to create cooperative solutions that extend beyond the boundaries of their own property. One way to quantize progress on stormwater is to see how closely a city or county follows the EPA's guidelines on stormwater management. Charlottesville is one of the few modern American cities yet to adopt their policies. I plan to research the history of cooperative water management solutions and Charlottesville's past to discover why these stormwater benchmarks have not been implemented. This will be researched through the SCOT framework to create a more informed and effective plan for stormwater development. The reasons for cooperative solutions, their benefit over individual solutions, and the success stories of other communities will all be used to create a compelling argument that acknowledges the values of the affected parties and applies them to increase appeal. The argument must also be applicable to private-versus-public debate which defines government attempts to resolve water management issues on private land.

Following a theme of sustainability and environmental preservation, my technical project involves the creation of a wearable mechanical generator that creates electrical power from the natural movement of the body while running. Many young people in America are already frequent runners, joggers, and/or gym-goers, relying on their smartphones for music or other

entertainment on the go. Empowering these individuals to charge their phones while exercising will reduce their impact on the electrical grid, a powerful draw for the increasingly large population of both personally and environmentally health-conscious consumers.

Technical Topic

The initial goal of this capstone project was to create a marketable product that generated electricity through mechanical motion. My team drew inspiration from "shake-to-charge" flashlights to harness the reciprocal motion of the human body while running. These flashlights generate power through induction; shaking them moves a magnet through a coil of wires which charges a capacitor. Our device is worn on the arm, which naturally moves back and forth while running to maintain balance. This moves the magnet inside and generates the current. Connecting a USB allows users to charge items like their phones while exercising.

The product is composed of the following components: a cylindrical neodymium rare-earth magnet, a hollow plastic tube, magnet wire, a power boost board, a battery, a case, and a sleeve with a pouch. The plastic tube is dimensioned so the magnet can slide easily within it, and the wire is wrapped around the tube in a large coil. This wire is connected to the power boost board, which converts the variable current from the coil into a current of the correct voltage to charge the battery. This boost board also acts as a USB port, pulling power from the battery to charge an external device. All of these components are secured within a 3D-printed case designed specifically for housing them, which itself is secured inside the armband pouch. Overall the device is small, light, and self-contained, optimal for the runners it is being marketed to.

The 3D-printed case is a key element to this product, it has been designed specifically for the available components and intended use. It is dimensioned to be as small as possible given the necessary components, with each component being held in place by the walls, lid, and interior columns of the case. The lid is secured with a snap-fit, meaning the product is assembled without any extra materials or methods. Simply place the components in their designated areas, attach the wires, and snap the lid shut. To further simplify assembly, the lid is symmetric and the areas of the case are marked according to which internal component belongs in them. 3D-printing the case also allows complete control over the ergonomics of the product, which will be catered to the unique environment in which it is operating. Special consideration will be given to the feel and rhythm of the device when it is worn while running.

The value of this design as a product will derive from the amount of power it is able to generate and the comfort while wearing it. The current objective is to work to improve the design to maximize both, while maintaining the ease of assembly and production that our current design allows. The convenience it provides as a phone charger on-the-go also makes it a tool for increasing sustainability. Younger consumers value both of these attributes highly, so emphasizing them through design and marketing is imperative to its success.

STS Thesis

Stormwater management in Albemarle County is not up to the standards of a modern and prosperous American city. From the familiar grounds of the University of Virginia to the country roads and farms spreading out radially from Charlottesville, flooding, runoff, erosion, and standing water are common occurrences. This is largely due to Charlottesville and

Albemarle County being one of the last major urban areas yet to adopt the EPA's guidelines on stormwater planning (EPA, 2018). Many municipalities in the United States that are both very similar and quite different from Charlottesville have succeeded in integrating the guidelines into their own stormwater systems with great success. This project will center around using Social Construction of Technology as a framework to explore the history and unique sociopolitical climate of Charlottesville and Albemarle County that has stymied stormwater infrastructure development towards the standards set by the EPA. This will be achieved through an archival study, interviews, and a comparative study between stormwater programs in Virginia and in Maryland.

A major concern in the battle for effective water management is the spread of impermeable land, which increases runoff and propagates water issues onto other properties. "Land development for houses, roads, and shopping malls increases the amount of impermeable surface. This in turn increases the amount of precipitation that becomes surface runoff, and can exacerbate flood problems downstream. In the language of economics, land development upstream creates a negative externality on people downstream" (Thompson, 1999). Individuals operating private land are already concerned with controlling the water that flows through it, however the concern ends where the property line does. Convincing these landowners that water is a communal problem with communal solutions is a goal Charlottesville has not yet achieved. One way to accomplish this is to reveal the extent of the impact poorly managed water can have on their land and on the land of others. "...water's materially connects individual bodies to the collective body politic; for example, by transporting vectors of disease and pollution. For this reason, the regulation and control of water-borne bodily wastes, the disposal of which has

become an intensely private activity under modernity, is thus an inescapably collective act, and is essential to the health of the population, as well as the individual" (Baker, 2012). While the city of Charlottesville has been urbanized to a more modern understanding of stormwater responsibility, the surrounding land has been farmland since settlers first colonized the area. In many ways the mentality of the cultivators of this land has remained unchanged as the amount of impermeable surfaces and chemicals used continues to increase.

Social Construction of Technology (SCOT) studies the ways in which new technologies and systems are influenced by society and how these influences manifest in their eventual design (Madsen, 2017). This research framework is a crucial element of my analysis of the political motives driving stakeholders to reject EPA guidelines. Combining the strategies used in other municipalities to earn the approval of affected groups by appealing to their needs with the unique viewpoints of Charlottesville's residents is the only way to make progress. "The aim of the SCOT analysis is to describe the stabilization process, the development of the technology in focus towards a more stable situation" (Madsen, 2017). Without an understanding of the forces driving the currently unstable relationship between the local government and the Charlottesville community, future stability cannot be achieved.

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